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APPLICANT (71):
ANT Nachrichtentechnik GmbH
Gerberstrasse 33
D-71522 Backnang (DE)

INVENTOR(S) (72):
David Rubin
Elbinger Strasse 93
D-71522 Backnang (DE)
Dieter Rupp
Bergäckerstrasse 13
D-71573 Allmersbach/T. (DE)
Ralf Mangold
Veilchenweg 2
D-71384 Weinstadt (DE)

TITLE	(54):	Arrangement for Acquiring and Exchanging Data between Moving Objects and Fixed Stations
FOREIGN TITLE	(54A):	Anordnung zum Erfassen und Austauschen von Daten zwischen beweglichen Objekten und Feststationen

ABSTRACT (57): 2.1. The invention relates to an arrangement for acquiring data from moving objects at fixed stations, wherein n fixed stations (4, 4', 4") in succession follow one another spaced a distance apart. The objects are each provided with a device that initiates a transaction and relays the respective signals to the fixed station (4, 4', 4") in whose zone (2) the corresponding object (1) is moving. The goal is to make the system more reliable.

2.2. The devices each have a memory in which a code for a fixed station and the time are stored after a transaction has taken place with said fixed station. Each fixed station exhibits a test module in which the contents in memory are evaluated before storing the code for the current fixed station. The usual transaction with the current fixed station is performed if a time span T_i exceeding a prescribed first time span T_{V1} has elapsed since the time stored in the memory, or if the code stored in memory is the code of the fixed station located before the current fixed station. Along with the usual transaction with the current fixed station, additional transactions provided at fixed stations before the current fixed station are performed, or a transaction encompassing the transactions at the preceding and current fixed stations is performed, if the stored code is for a more remote, preceding fixed station, and time span T_i is less than a prescribed time T_{V2}.

2.3. The invention can be used in automatic toll road collection systems.

The invention relates to an arrangement for acquiring and exchanging data between moving objects and fixed stations, wherein n fixed stations (n e IN) in succession follow one another spaced a distance apart, wherein the objects are each provided with a device which, when activated from outside, initiates a transaction and relays the respective signals to the fixed station in whose zone the corresponding object is moving.

The invention can be used in automatic toll collection systems. Automatic toll collection systems are based on the use of microwaves or infrared at a fixed station to establish a connection to a device in the vehicle that performs a transaction, e.g., debits a check card worth a certain sum of money or transfers an identification number for subsequent debiting of an account. This transaction takes place for as long as the vehicle, or device inside the vehicle, lies within range of the transmitter and receiver of the fixed station. This remains the case for as long as the device in the vehicle remains in a defined area, the communication zone. An automatic toll collection system often consists of a series of fixed stations that are each arranged between entry and exit ramps on certain roads.

One such toll collection system is known from DE 41 07 803 A1. If a device in a vehicle occasionally fails, e.g., due to an empty battery, no communication takes place with a fixed station as the vehicle passes it by. Since the toll is not debited, the corresponding vehicle is photographed, so that the vehicle owner can be identified based on the license plate and charged what then are most often much higher tolls. As a result, the vehicle owner incurs a loss. Tolls are also not debited if a fixed station is at times put out of commission by outside influences, e.g., lightning strikes or the like. This loss must be borne by the system operator.

The object of the invention is to specify an arrangement for acquiring and exchanging data between moving objects and fixed stations with enhanced reliability, especially relative to failures of the fixed station and occasional device malfunctions. One special object of the invention is to indicate an arrangement for charging a toll for vehicles that displays an enhanced reliability even if a system component fails.

This object is achieved with the features of Claim 1. The subclaims indicate advantageous further developments.

Known automatic toll collection systems are able to identify the license plates of vehicles that fail to debit the toll at a fixed station. This failure to debit might be due to an empty battery in the device on board the vehicle. Once the empty battery has been replaced, the invention makes it possible to also debit the toll at the next station for the station where the device had failed. The invention also permits debiting tolls for a fixed station at the next fixed station if the initial fixed station has been knocked out by outside influences. Each fixed station is provided with means that transmit a code for the fixed station. Every device in the moving object has a memory in which the fixed station code is stored after a completed transaction. This memory also stores the time, e.g., when the transaction took place.

As a vehicle travels down a highway with a series of fixed stations spaced a distance apart from each other, the code and time stored in memory changes from station to station. The memory must not rely on batteries, and only be large enough to hold one code and time that are then overwritten at the next fixed station. At the beginning of a transaction, the data stored in memory can be sent from the device to the fixed station. The memory content is then evaluated in a test module of the fixed station. For example, if the content is more than two hours old, i.e., the time span T_l elapsed since the stored time exceeds prescribed time span T_{vl}, it is assumed that the content is no longer up-to-date, and a conventional transaction takes place with the current fixed station, meaning that the usual toll for this fixed station is debited. If the memory contains the code for the fixed station located before the current fixed station, the toll required there is also debited at the current fixed station. A conventional transaction hence takes place. If the memory contains a code belonging

to a fixed station located even before the last fixed station, the time span T_i elapsed since the code was stored is compared with prescribed time spans.

There are here several possibilities:

1.) Regardless of the fixed station to which the stored code belongs, time span T_i is compared with a prescribed time span T_{V2}, wherein $T_{V2} \leq T_{V1}$;

2.) Depending on the fixed station (j-i-1), i=1,2,3,..., before the last fixed station (j-1) to which the stored code belongs, time span Ti is compared with a prescribed time span

$$T_{V2}^{j-i-1},$$

belonging to this code, with

$$T_{V2}^{j-i-1} \leq T_{V1}, (i \in IN)$$

In the simplest case, then, only the time $T_{V1} = T_{V2}$ is stipulated in the test module, and in the most complex case, times T_{V1}

$$T_{V2}^{j-2}, T_{V2}^{j-3}, \ldots T_{V2}^{j-m}$$

are stipulated, wherein m is a logical ceiling for the number of omitted and retrievable transactions.

$$T_{V2}^{j-m} - T_{V2}^{j-m+1} \geq T_{V1} - T_{V2}^{j-m}$$

yields such a limit, for example.

The dimensioning for the time spans in the test module must be logically selected based on the distances between the fixed stations and the allowed speeds. Excessive values can lead to false debits in cases where a vehicle leaves the highway and gets back on again later.

If time spans T_{V2} and T_{V1} have been stored in the test module and the time span T_i elapsed since this code was stored is smaller than the stipulated time span T_{V2} ($T_{V2} \leq T_{V1}$), it is assumed that either the device malfunctioned at the last fixed station, or the fixed station itself was not operational. Instead of a usual transaction with the current fixed station in which the toll required at this fixed station is debited, a toll equaling the toll of the current station plus the toll of the preceding station is debited. Therefore, it can be said that the usual transaction is accompanied by another transaction, but both can take place in a single transmission by debiting the sum of the tolls. In other words, it is possible to perform a transaction that encompasses the transaction of the current fixed station and that of the station where no transaction has taken place. After the transaction, the code for the corresponding fixed station is stored in memory along with the time. In addition to comparing the fixed station codes, the time must also be taken into account, since a vehicle might conceivably take an exit ramp to leave the road before a fixed station, and then use an entry ramp after the fixed station to get back on the road. Of course, no road charge is then incurred for the circumvented fixed station, so that no road charge can be debited either. However, this can be covered using prescribed time intervals. Tolls are then collected after the fact on all vehicles for which a specific time span has not elapsed since the time stored in memory. A high number of vehicles could be detected in this way. Only those vehicles that take rest stops or break down would not be recorded. Another arrangement can be used to resolve this case. Should a device in a vehicle fail and the vehicle be

photographed by a fixed station, it is also important that the vehicle owner not be identified if the toll previously due is subsequently debited at the next station. To achieve this, photographs are also taken of vehicles at stations where subsequent tolls are debited in order to compare these photographs to ones taken of vehicles for which no toll was debited in a central computer to which the photographs are forwarded (by data line, directional radio or courier). The acts of "not debiting" at a first station and "subsequently debiting" at a second station are then combined, so that the program running in the central computer to identify the owner of the vehicle can be automatically stopped.

An automatic toll collection system according to the invention therefore offers advantages to both the system operator and the user. The operator loses fewer tolls given the elevated reliability of the overall system, without having to double the number of individual devices to increase dependability, making the system considerably more expensive. In addition, the administrative costs to the operator for determining the owners of vehicles who initially failed to pay at a fixed station can be substantially reduced if tolls can be collected after the fact at the next station. It is also far more convenient for the user, who does not have to pay a higher toll just because the device in his/her vehicle has failed.

In addition to applying the invention to automatic toll collection systems for vehicles driving on the open road, this system can of course also be used for other objects traveling along prescribed routes. A transaction here does not necessarily have to entail debiting a toll; rather, it can also involve another type of identification or similar process that takes place between the fixed station and the device via communication.

An exemplary embodiment will be explained based on the figures. Shown on:

Fig. 1 is a top view of a zone within which vehicle tolls are determined, and

Fig. 2 is an abbreviated view of a roadway with several fixed stations and vehicles that travel different routes and pay different tolls.

The arrangements described below are used to localize moving objects within a prescribed zone and perform a transaction. As evident from the figures, these moving objects can be, for example, vehicles 1. The prescribed zone 2 is then a section of road on which communication with a fixed station 4 is enabled. The prescribed zone 2 is also called the communication zone. Each vehicle 1 has a device visible from outside and preferably situated on the windshield that exhibits a receiver, a transmitter, a processor, e.g., which debits a required toll from a check card worth a certain amount of money, and a memory, e.g., an EEPROM. A vehicle is first located in zone 3, where no communication takes place. Once it enters the communication zone 2 of a fixed station 4, the transaction with the device takes place. For example, this can take place using a microwave signal transmitted from the antenna of the fixed station 4.

Fig. 2 shows a three-lane road 7 with an entry ramp 5 and exit ramp 6. Three fixed stations 4, 4', 4" are arranged on this road 7. Different codes j, j-1 and j-2 are allocated to the fixed stations. The system will be explained based on individual vehicles that travel varying distances. Vehicle 1 initially passes fixed station 4, and there receives code j-2. Vehicle 1 then passes fixed station 4'. In this example, it is assumed that fixed station 4' has failed, e.g., due to a lightning strike. This is denoted by a cross through fixed station 4' on Fig. 2. Vehicle 1 hence is still bears code j-2 of fixed station 4 along with the corresponding time in the device memory even after passing fixed station 4'. Vehicle 1 now continues driving, and passes fixed station 4". The test module there detects that vehicle 1 has the code for fixed station 4 stored in the device memory. Since the time span T_i elapsed since the time stored in the device memory of vehicle 1 is less than a time span T_V stored in the test module ($T_V = T_{V1} = T_{V2}$), the tolls payable at fixed station 4' and at fixed station 4" are debited at fixed station 4". If a vehicle 1' leaves the road 7 using the exit ramp 6 after the failed fixed station, the toll is not subsequently paid. The same holds true for a vehicle 1" that only gets on the road 7 via entry ramp 5 shortly before the fixed station 4' that has failed. Only the toll due at this station is

collected at fixed station 4" there too. The vehicles 1 and 1" that have passed fixed station 4" receive code j of this station and the corresponding time from the fixed station, and store them in the device memory. The failure of a fixed station is similar to the malfunction of a device in a vehicle 1 in the area of station 4', for example. The corresponding toll can then also be paid after the fact in station 4". Since a photograph of the vehicle 1 was taken at station 4', a photograph of the vehicle 1 is also recorded at station 4". Both photographs are transmitted to a central computer and there combined, so that no efforts to identify and track the owner of vehicle 1 are initiated.

Claims

1. Arrangement for acquiring and exchanging data between moving objects (1) and fixed stations (4), wherein n fixed stations (4) ($n \in IN$) in succession follow one another spaced a distance apart, wherein the objects (1) are provided with a device which, when activated from outside, initiates a transaction and relays the respective signals to the fixed station (4) in whose zone (2) the corresponding object (1) is moving, characterized in that
the device has a memory in which a fixed station code and time are stored after a transaction has been completed with a fixed station,
each fixed station exhibits a test module in which the contents in memory are evaluated before storing the code for the current j-th fixed station ($j \in \{1,\ldots,n\}$),
the usual transaction with the current fixed station is performed if a time span T_i exceeding a prescribed first time span T_{VI} has elapsed since the time stored in the memory, or if the code stored in memory is the code of the (j-1)-st fixed station located before the current j-th fixed station,
along with the usual transaction with the current fixed station, additional transactions provided at i fixed stations ($i \in IN$) before the current j-th fixed station are performed, or a transaction encompassing the transactions at i preceding fixed stations and at the current fixed station is performed, if the stored code is for the (j-1-i)-th fixed station, and time span T_i is less than a prescribed time span

$$T_{V2}^{j-1-i} \quad (T_{V2}^{j-1-i} \leq T_{VI})$$

belonging to the (j-1-i)-th fixed station.

2. Arrangement according to Claim 1, characterized in that at least one prescribed time span T_{VI} is stored in each test module.

3. Arrangement according to one of Claims 1 or 2, characterized in that the device transmits the data stored in memory to the fixed station at the beginning of a transaction.

4. Arrangement according to one of Claims 1 to 3, characterized in that, after a transaction with a fixed station is complete, the data stored in memory are overwritten with the current data, code for the current fixed station and time.

5. Arrangement according to one of Claims 1 to 4, characterized in that the data are kept in memory even if the device is intentionally or unintentionally deactivated between two fixed stations.

6. Arrangement according to one of Claims 1 to 5, characterized in that the fixed stations are linked to a central computer, objects are photographed at fixed stations if
   a) no transaction takes place, or
   b) other transactions in addition to the conventional transaction are performed, and that the photographic data are transported to the central computer and there compared.

7. Arrangement according to one of Claims 1 to 6, characterized in that the arrangement is used to determine tolls for vehicles (1) traveling along a roadway.

8. Arrangement according to Claim 7, characterized in that the vehicles (1) are provided with a device which, when activated from outside, debits the required toll from a check card or transfers an identification number for subsequently debiting the required toll from an account.

9. Arrangement according to Claim 8, characterized in that, if the stored code is for the (j-1-i)-th fixed station and the time span

$$T_i < T_{V2}^{j-1-i} \leq T_{V1},$$

the required toll is equal to the sum of tolls for the j-th to (j-i)-st fixed stations.

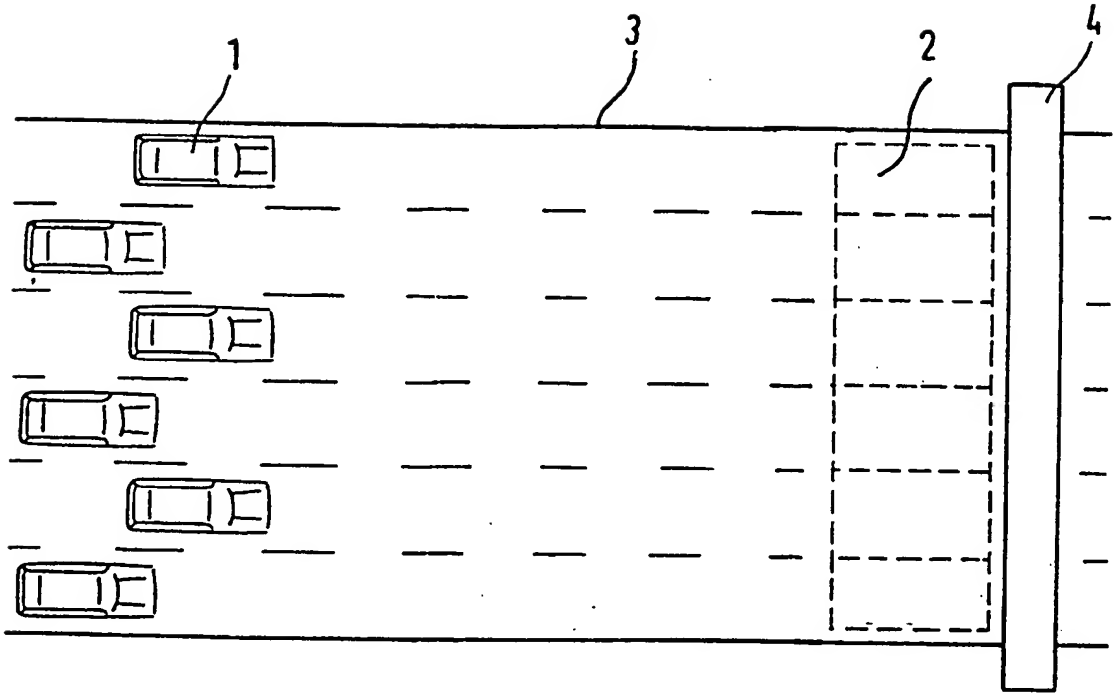

Fig.1

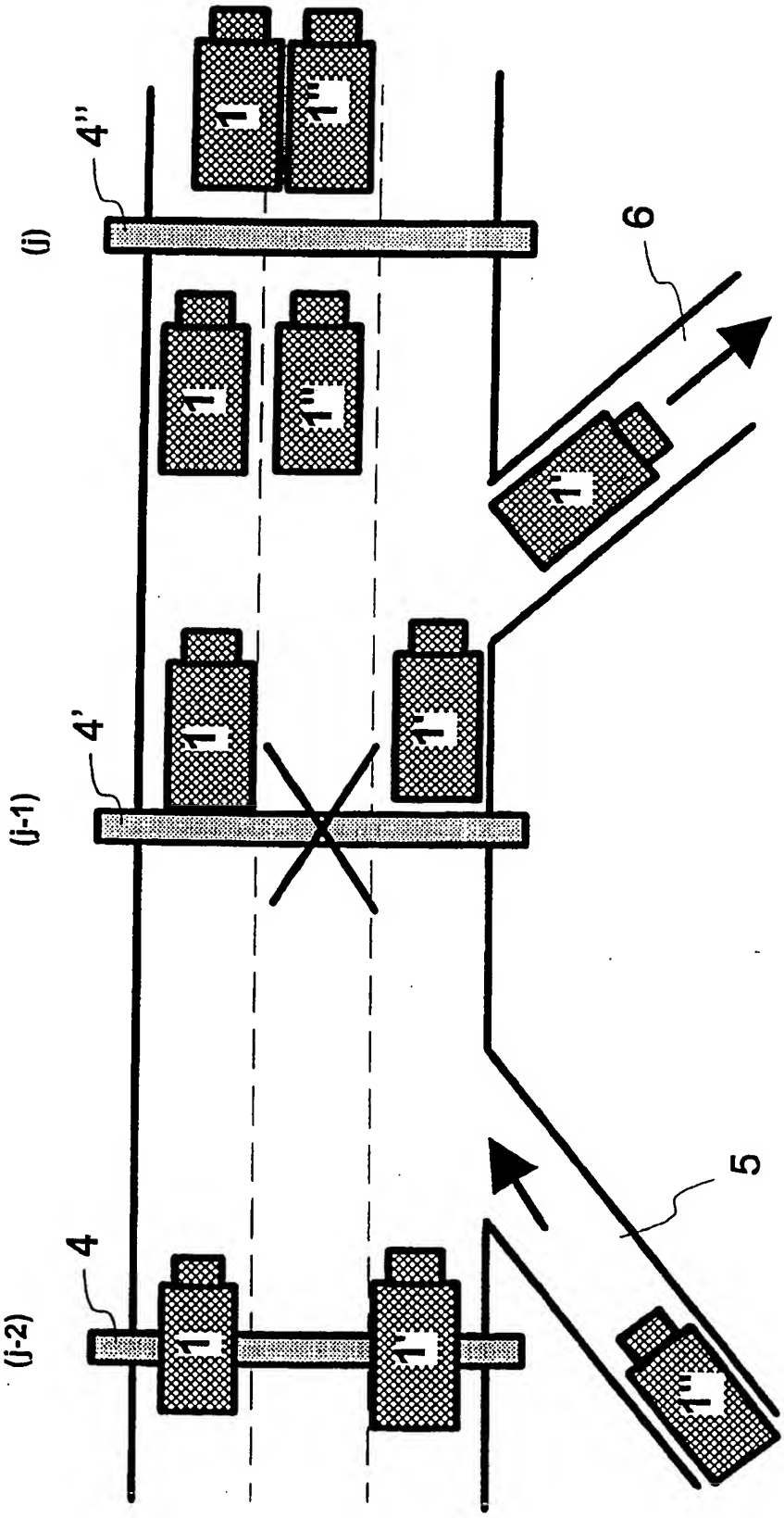

Fig. 2

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APPLICANT (71): ANT Nachrichtentechnik GmbH
D-71522 Backnang (DE)

INVENTOR(S) (72): David Rubin
D-71522 Backnang (DE)
Dieter Rupp
D-71573 Allmersbach/T. (DE)
Ralf Mangold
D-71384 Weinstadt (DE)

TITLE (54): Arrangement for Acquiring and Exchanging Data between Moving Objects and Fixed Stations

FOREIGN TITLE (54A): Anordnung zum Erfassen und Austauschen von Daten zwischen beweglichen Objekten und Feststationen

ABSTRACT (57): 2.1. The invention relates to an arrangement for acquiring data from moving objects at fixed stations, wherein n fixed stations (4, 4', 4") in succession follow one another spaced a distance apart. The objects are each provided with a device that initiates a transaction and relays the respective signals to the fixed station (4, 4', 4") in whose zone (2) the corresponding object (1) is moving. The goal is to make the system more reliable.

2.2. The devices each have a memory in which a code for a fixed station and the time is stored after a transaction has taken place with said fixed station. Each fixed station exhibits a test module in which the contents in memory are evaluated before storing the code for the current fixed station. The usual transaction with the current fixed station is performed if a time span T_i exceeding a prescribed first time span T_{V1} has elapsed since the time stored in the memory, or if the code stored in memory is the code of the fixed station located before the current fixed station. Along with the usual transaction with the current fixed station, additional transactions provided at fixed stations before the current fixed station are performed, or a transaction encompassing the transactions at the preceding and current fixed stations is performed, if the stored code is for a more remote, preceding fixed station, and time span T_i is less than a prescribed time T_{V2}.

2.3. The invention can be used in automatic toll road collection systems.

EP 0 632 410 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application No. EP 94 10 9378

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Designation of document with indication, if necessary, of relevant passages	Relates to claim	CLASSIFICATION OF APPLICATION (Int.Cl.6)
A	US 4 303 904 A (CHASEK NORMAN E) * Abstract; claims; figures * * Col. 3, line 44 – Col. 4, line 4 * * Col. 5, line 1 – Col. 6, line 2 * -----	1, 3-8	H04L9/00 G07B15/00
A, D	DE 41 07 803 A (ANT NACHRICHTENTECH) * Abstract; claims; figures * -----	1, 3, 6	
A	EP 0 401 192 A (BAETS THIERRY DE) * Abstract; claims; figures * -----	1	
A	EP 0 425 961 A (AUTOSTRADE CONCESS CONST) * Abstract; claims; figures * -----	1	
A	WO 92 10824 A (BOSCH GMBH ROBERT) -----		
			SEARCHED FIELDS (Int.Cl. 6)
			G07B G06K

This search report was generated for all patent claims. The present search report has been drawn up for all claims.		
Search location DEN HAAG	Search concluded on December 8, 1997	Examiner Meyl, D

CATEGORY OF CITED DOCUMENTS	
X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate literature	T: theory or principle underlying the invention E: earlier patent document, but published on, or after filing date D: document cited in the application L: document cited for other reasons --- &: member of the same patent family, corresponding document

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(71) Anmelder:
ANT Nachrichtentechnik GmbH
D-71522 Backnang (DE)

(72) Erfinder:
- **Rubin, David**
  D-71522 Backnang (DE)
- **Rupp, Dieter**
  D-71573 Allmersbach/T. (DE)
- **Mangold, Ralf**
  D-71384 Weinstadt (DE)

(54) Anordnung zum Erfassen und Austauschen von Daten zwischen beweglichen Objekten und Feststationen

(57) 2.1 Die Erfindung betrifft eine Anordnung zum Erfassen von Daten von beweglichen Objekten an Feststation, wobei n Feststationen (4, 4', 4") unter Abstand aufeinander folgen. Die Objekte sind mit je einer Einrichtung versehen, die eine Transaktion veranlaßt und die Signale jeweils an die Feststation (4, 4', 4") abgibt, in deren Zone (2) sich das entsprechende Objekt (1) bewegt. Die Zuverlässigkeit des Systems soll erhöht werden.

2.2 Die Einrichtungen weisen jeweils einen Speicher auf, in dem nach erfolgter Transaktion mit einer Feststation eine Kennung für diese und die Zeit abgelegt wird. Jede Feststation weist ein Prüfmodul auf, in dem der Inhalt des Speichers vor der Ablage der Kennung der aktuellen Feststation ausgewertet wird. Die übliche Transaktion mit der aktuellen Feststation wird durchgeführt, falls seit der im Speicher abgelegten Zeit eine Zeitspanne T_i vergangen ist, die größer als eine vorgegebene erste Zeitspanne T_{V1} ist, oder falls die im Speicher abgelegte Kennung die Kennung der vor der aktuellen Feststation gelegenen Feststation ist. Neben der üblichen Transaktion mit der aktuellen Feststation werden weitere an Feststationen vor der aktuellen Feststation vorgesehene Transaktionen durchgeführt bzw. eine Transaktion durchgeführt die die Transaktionen an der vorhergehenden und der aktuellen Feststationen umfaßt, falls die abgelegte Kennung, die einer weiter entfernten vorhergehenden Feststation ist, und die Zeitspanne T_i kleiner als eine vorgegebene Zeit T_{V2} ist.

2.3 Die Erfindung kann bei Systemen zur automatischen Gebührenerfassung im Straßenverkehr eingesetzt werden.

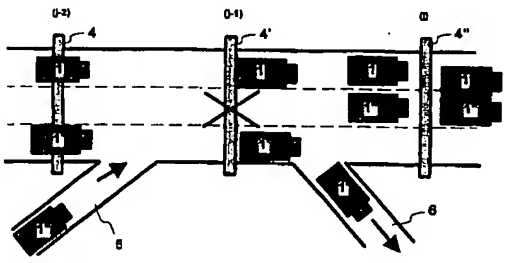

Fig. 2

EP 0 632 410 A3

Europäisches Patentamt

EUROPÄISCHER RECHERCHENBERICHT

Nummer der Anmeldung
EP 94 10 9378

EINSCHLÄGIGE DOKUMENTE

Kategorie	Kennzeichnung des Dokuments mit Angabe, soweit erforderlich, der maßgeblichen Teile	Betrifft Anspruch	KLASSIFIKATION DER ANMELDUNG (Int.Cl.6)
A	US 4 303 904 A (CHASEK NORMAN E) * Zusammenfassung; Ansprüche; Abbildungen * * Spalte 3, Zeile 44 - Spalte 4, Zeile 4 * * Spalte 5, Zeile 1 - Spalte 6, Zeile 2 *	1,3-8	H04L9/00 G07B15/00
A,D	DE 41 07 803 A (ANT NACHRICHTENTECH) * Zusammenfassung; Ansprüche; Abbildungen *	1,3,6	
A	EP 0 401 192 A (BAETS THIERRY DE) * Zusammenfassung; Ansprüche; Abbildungen *	1	
A	EP 0 425 961 A (AUTOSTRADE CONCESS CONST) * Zusammenfassung; Ansprüche; Abbildungen *	1	
A	WO 92 10824 A (BOSCH GMBH ROBERT)		

RECHERCHIERTE SACHGEBIETE (Int.Cl.6)

G07B
G06K

Der vorliegende Recherchenbericht wurde für alle Patentansprüche erstellt

Recherchenort	Abschlußdatum der Recherche	Prüfer
DEN HAAG	8.Dezember 1997	Meyl, D

KATEGORIE DER GENANNTEN DOKUMENTE

X : von besonderer Bedeutung allein betrachtet
Y : von besonderer Bedeutung in Verbindung mit einer anderen Veröffentlichung derselben Kategorie
A : technologischer Hintergrund
O : nichtschriftliche Offenbarung
P : Zwischenliteratur

T : der Erfindung zugrunde liegende Theorien oder Grundsätze
E : älteres Patentdokument, das jedoch erst am oder nach dem Anmeldedatum veröffentlicht worden ist
D : in der Anmeldung angeführtes Dokument
L : aus anderen Gründen angeführtes Dokument

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